84005-400

(97—134Vac; 47– 440Hz Input)

400W, Single Phase,

PFC Boost Converter Module

The **84005-400** PFC boost converter module, when configured with external filter and hold-up capacitors, contains all the circuitry necessary for complete power line compliance with aeronautics specification RTCA/DO-160D and Boeing's D6-44588. Housed within a 5-sided aluminum enclosure, the **84005-400** is embedded with a high quality silicon-based thermal encapsulant facilitating optimum performance within the harshest environments. Providing line rectification, minimized input current harmonic distortion content, active inrush current limiting and near unity power factor; the **84005-400** is ideal for avionics' applications where power demands are in the 200W-400W range.

A tightly regulated 325Vdc output provides necessary input to a variety of off-the-shelf DC/DC converter modules. Utilizing a modular approach, system power supplies are easily configured with few individual components required. Tedious design and development cycles normally associated with custom power solutions are no longer necessary with this approach. Reliable, compliant power supplies can be configured in weeks, not months, without the need for specialized Power Supply Engineers.

FEATURES

	EXCEEDS BOEING SPECIFICATION D6-44588 (AA) FOR POWER FACTOR AND INPUT CURRENT HARMONIC DISTORTION LEVELS @ 400 +/- 10%
	WIDE INPUT VOLTAGE RANGE: 97 - 134Vrms; 47 - 440Hz
	STANDARD 325Vdc OUTPUT COMPATIBLE WITH BROAD RANGE OF *OFF-THE-SHELF* DC/DC CONVERTER MODULES
	COMPLIES WITH RTCA/D0-160D, CATEGORY M FOR CONDUCTED EMISSIONS & SUSCEPTIBILITY (WITH EXTERNAL FILTER)
	FULL LOAD EFFICIENCY: 89% TYPICAL
	VL94V-0 FLAMMABILITY CLASSIFICATION
	RUGGEDIZED SILICON-BASED ENCAPSULATED CONSTRUCTION
	SIZE: 5.41" x 2.98" x 1.68", WEIGHT: 26oz.
	ACTIVE INRUSH CURRENT LIMITING
	OVERVOLTAGE AND THERMAL PROTECTION

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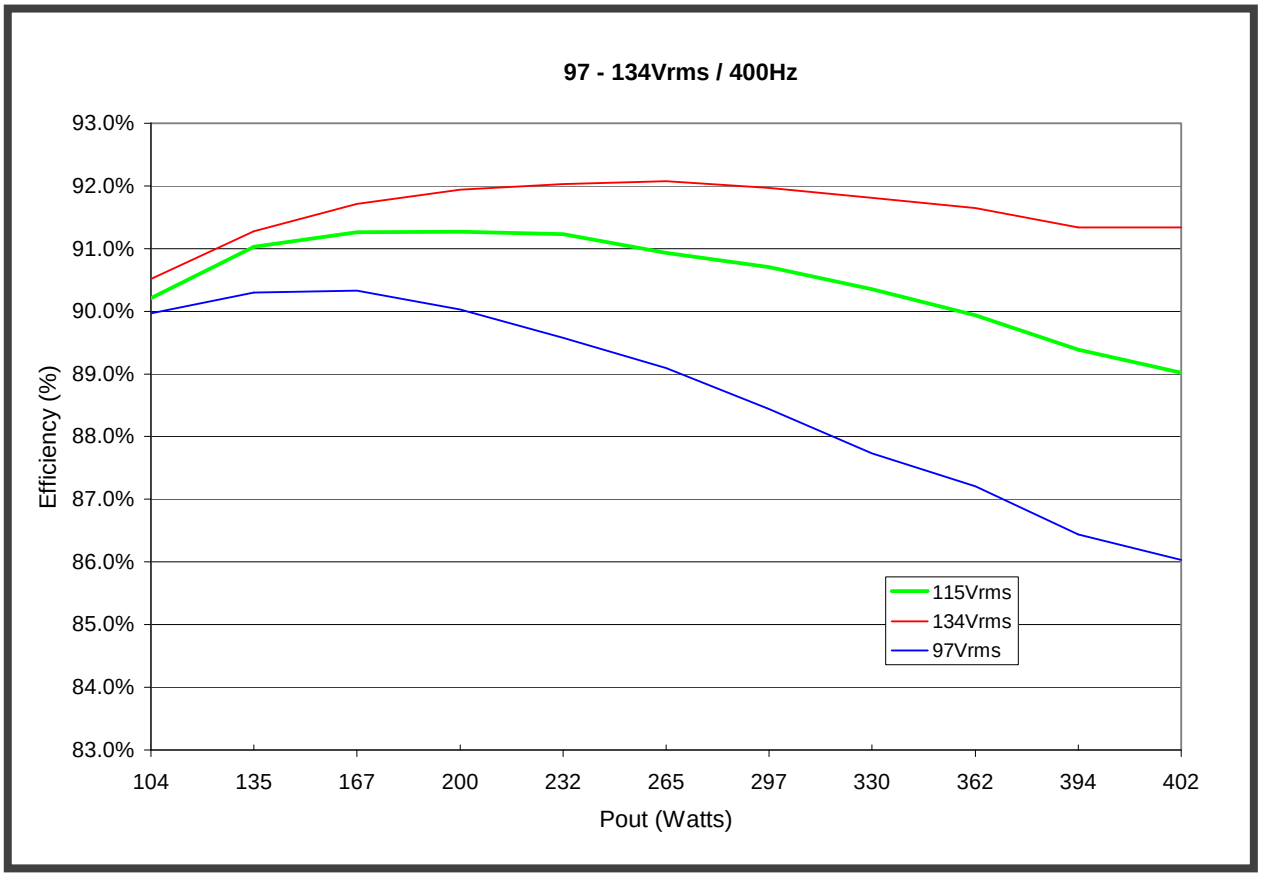
TEMPERATURE CHARACTERISTICS (TYPICAL)

*AIRFLOW (LFM)	THERMAL IMPEDANCE (Θs-a) (°C/W)
0 LFM	1.30
250 LFM	0.75
500 LFM	0.60
750 LFM	0.40

1. Air velocity measured using a digital anemometer positioned within an airflow duct 1" X 3" above top of module
2. Module flush mounted to a 10.0” x 7.0” x 0.06” aluminum plate
3. Thermal impedance values provided are at module’s rated output power (400W)

EFFICIENCY CURVE (TYPICAL)



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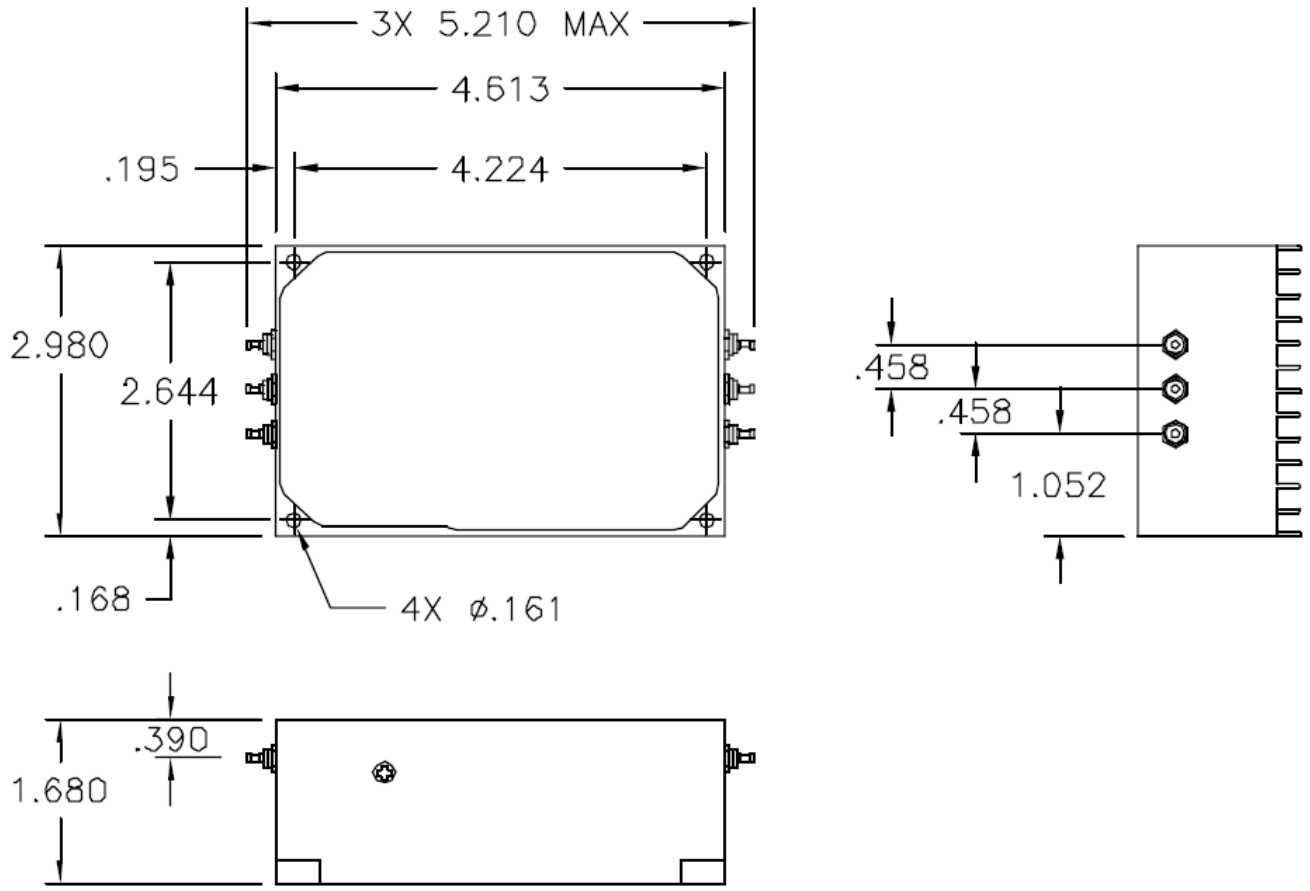
MECHANICAL DIAGRAM



UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES

DECIMALS	ANGULAR
.XX ±.02	±.5°
.XXX ±.010	

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ELECTRICAL SPECIFICATIONS

UNLESS OTHERWISE SPECIFIED THE FOLLOWING TEST CONDITIONS APPLY: T_A=25°C. COMBINATION OF CONSTANT ACTIVE AND RESISTIVE LOAD APPLIED TO OUTPUT IN PARALLEL WITH 470uF CAPACITOR. INPUT VOLTAGE = 115Vrms, 400Hz, < 1.25% THD SINUSOID. INPUT FILTER INSTALLED ON INPUT AC LINES (SEE APPLICATION NOTES FOR DETAILS).

INPUT CHARACTERISTICS

PARAMETER	*84005-400*	*REMARKS*	*NOTES*
INPUT VOLTAGE RANGE	97 - 134Vrms	COMPLIES WITH NORMAL/ ABNORMAL INPUT VOLTAGES PER RTCA/DO-160D, SECTION 16	2
INPUT FREQUENCY RANGE	47 - 440Hz	INPUT CURRENT HARMONIC DISTORTION OPTIMIZED @ 400Hz OPERATION; OPERATES DOWN TO 47Hz WITH REDUCED DISTORTION PERFORMANCE	2
CONTINUOS OUTPUT POWER	400W	OBSERVE MAXIMUM BASEPLATE TEMPERATURE	2
PEAK POWER RATING	450W	< 30 SECOND DURATION; Vin ≥ 104Vrms	1
INPUT CURRENT	5.0Arms maximum at peak load; 4.8Arms maximum at max load; 3.9Arms nominal at max load	OCCURS AT PEAK LOAD (450W) AND Vin = 104Vrms; OCCURS AT MAX CONT LOAD (400W) AND MINIMIUM LINE (97Vrms); OCCURS AT MAX CONT LOAD (400W) AND NOMINAL LINE (115Vrms)	1
LEAKAGE CURRENT	< 5mArms	AC LINE/NEUTRAL TO CHASSIS, Vin = 115Vrms / 400Hz	1
INRUSH CURRENT	17Apk (12Arms) maximum	COLD START, Vin = 115Vrms / 400Hz	2
INPUT CAPACITANCE	0.82uF +/- 20%	LINE-TO-LINE, X2 CLASS	1
TOTAL HARMONIC DISTORTION (INPUT CURRENT)	6% maximum 5% maximum	200W ≤ Pout < 300W 300W ≤ Pout ≤ 400W	2
INDIVIDUAL HARMONICS - AC CLEAN	EVEN: < 1% I_f / n, (n < 10) EVEN: < 0.1% I_f , (n ≥ 10) ODD: < 30% I_f / n ODD TRIPLENS: < 15% I_f / n	I_f = Fundamental Current Vin = 115Vrms, 360Hz – 440Hz Vthd ≤ 1.25% n = Order of Harmonic; 1 thru 40; For All Pout ≥ 200W and Individual Harmonics > 5mArms	1
INDIVIDUAL HARMONICS - DISTORTED INPUT	EVEN: < 1% I_f / n + Vn (n < 10) EVEN: <0.1% I_f + Vn (n ≥ 10) ODD: < 30% I_f / n + Vn ODD TRIPLENS: <15% I_f / n+Vn	I_f = Fundamental Current Vin = 115Vrms, 360Hz – 440Hz Vthd ≥ 5% n = Order of Harmonic; 1 thru 40; For All Pout ≥ 200W and Individual Harmonics > 5mArms	1
POWER FACTOR	0.90 min	Pout > 150W	2
INPUT TRANSIENT SURGE WITHSTAND	30J / 2mSec	NORMAL MODE	1
CREST FACTOR (CURRENT)	1.314 - 1.514	RATIO OF PEAK/ RMS	1
START-UP TIME (Tamb = 25°C)	< 600mSecs	Vout > 200Vdc, Pout > 200W	2

INPUT CHARACTERISTICS—CONTINUED

PARAMETER	*84005-400*	*REMARKS*	*NOTES*
CONDUCTED EMISSIONS	RTCA DO160D, Section 21, Category M	REQUIRES EXTERNAL FILTER. SEE APP NOTES FOR DETAILS	1
OPERATING TEMP RANGE	-40°C TO 85°C	ENCLOSURE TEMPERATURE; NO OUTPUT POWER DERATING REQUIRED FOR OPERATION UP TO 85°C ENCLOSURE TEMP	1
STORAGE TEMP RANGE	-55°C TO 85°C	NON-OPERATIONAL	1
MAXIMUM BASEPLATE TEMPERATURE	85°C	MAXIMUM ALLOWABLE SUSTAINED BASEPLATE TEMPERATURE WHEN OPERATING.	1
OVERTEMPERATURE PROTECTION SET POINT	105°C + 10°C, -15°C	MODULE HOT SPOT TEMPERATURE WHILE THE MODULE IS OPERATING. BOOST FUNCTION IS INHIBITED WHEN OVER-TEMPERATURE FAULT IS DETECTED. DURING INHIBIT, MODULE OUTPUT OPERATES AT √2*Vin (rms). MODULE WILL AUTO RESTART AFTER COOLING DOWN WITH APPROXIMATELY 15°C HYSTERESIS	1
INPUT UNDER-VOLTAGE DISABLE	95Vrms +/-5Vrms	BOOST FUNCTION IS INHIBITED 500mSec AFTER INPUT VOLTAGE IS SENSED BELOW THIS VALUE. DURING INHIBIT, MODULE OUTPUT OPERATES AT √2*Vin(rms).	2

Notes:

1. Ensured by design, not 100% tested in production.
2. 100% tested for specification compliance in production.

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(97—134Vac; 47– 440Hz Input)

400W, Single Phase,

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OUTPUT CHARACTERISTICS

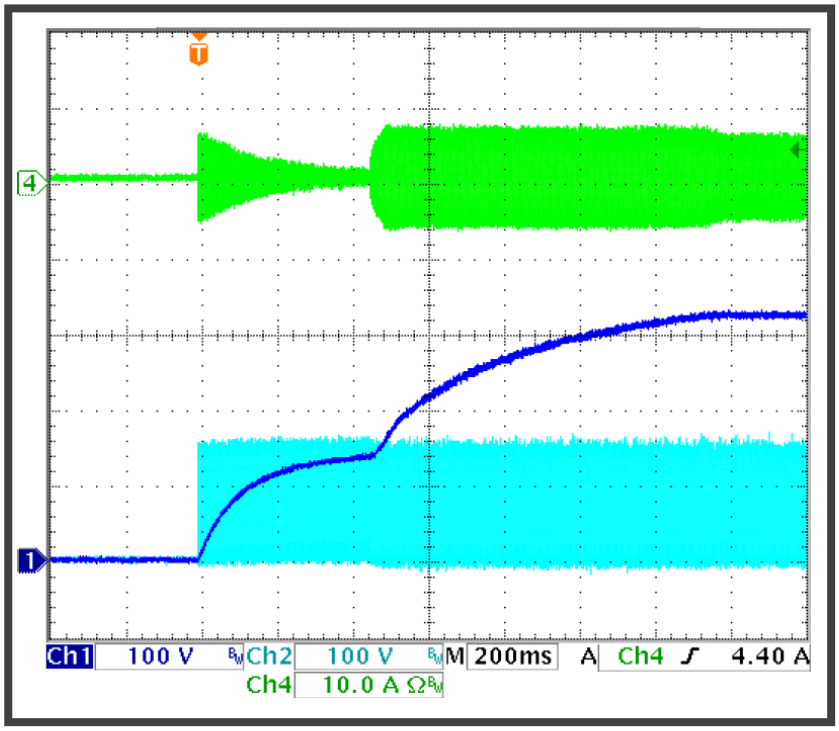
PARAMETER	*84005-400*	*REMARKS*	*NOTES*
RATED OUTPUT VOLTAGE	325Vdc+/-3%	Cout ≥ 470uF, ALL LINE AND LOAD CONDITIONS	2
CONTINUOS OUTPUT POWER	400W	OBSERVE MAXIMUM BASEPLATE TEMPERATURE	2
PEAK POWER RATING	450W	< 30 SECOND DURATION; Vin ≥ 104Vrms	1
OUTPUT CURRENT	1.27Arms at 400Wout (continuous power) 1.43Arms at 450Wout (peak power for < 30 seconds)	MODULE REQUIRES A CAPACITOR CONNECTED TO THE OUTPUT TERMINALS FOR PROPER OPERATION (470uF minimum).	1
MINIMUM OUTPUT CURRENT	0Adc	NO LOAD REQUIRED FOR PROPER OUTPUT REGULATION	2
TEMPERATURE STABILITY COEFFICIENT	< 0.02% / °C	OUTPUT VOLTAGE Cout ≥ 470uF, ALL LINE AND LOAD CONDITIONS	1
LINE REGULATION	< 1%	OUTPUT DEVIATION FOR ± 20% STEP CHANGE IN LINE VOLTAGE; Cout ≥ 470uF	1
OUTPUT RIPPLE + NOISE (pk-pk)	< 0.5%	Cout ≥ 470uF, 20MHz BW, ALL LINE AND LOAD CONDITIONS.	1
HOLD-UP TIME	0mSec	REQUIRES EXTERNAL HOLD-UP CAPACITOR TO EXTEND SUPPLY LEVEL HOLD-UP TIME; SEE APPLICATION NOTES FOR DETAILS	1
WARM START DELAY (AFTER MOMENTARY INPUT AC POWER INTERRUPTS)	200mSec	MAXIMUM TIME DELAY BETWEEN THE TIME THE INPUT IS REAPPLIED AND WHEN THE OUTPUT BEGINS TO CHARGE POSITIVE FOLLOWING MOMENTARY POWER INTERRUPTS OF LESS THAN 400mSec	2
MINIMUM OUTPUT CAPACITANCE	470uF	OBSERVE RIPPLE CURRENT REQUIREMENTS @ 800Hz & 100kHz FOR EXTERNAL OUTPUT CAPACITORS	1
MAXIMUM OUTPUT CAPACITANCE	10,000uF	SPECIFIED IN ORDER NOT TO OVERSTRESS THE INTERNAL ACTIVE INRUSH CURRENT LIMITING CIRCUIT	1
ISOLATION VOLTAGE INPUT/OUTPUT TO CHASSIS	1500Vac / 60Hz / 60 Seconds 15mArms max leakage current	INPUT "Y" SUPPRESSION CAPACITORS INSTALLED. LEAKAGE CURRENT FOR ANY INPUT OR OUTPUT TERMINAL TO CHASSIS TERMINAL (or enclosure). NO ARCING OR DAMAGE WILL OCCUR	2
ISOLATION VOLTAGE INPUT/OUTPUT TO CHASSIS	1500Vac / 60Hz / 60 Seconds 1.5mArms max leakage current	INPUT "Y" SUPPRESSION CAPACITORS REMOVED. LEAKAGE CURRENT FOR ANY INPUT OR OUTPUT TERMINAL TO CHASSIS TERMINAL (or enclosure). NO ARCING OR DAMAGE WILL OCCUR	1
SHORT-CIRCUIT PROTECTION	NONE	FUSE INPUT WITH 7A FAST BLOW FUSE	1
INPUT AC POWER FAIL STATUS "ACGOOD-H"	OPEN COLLECTOR SIGNAL, TRANSITIONS TO 0.8V MAXIMUM WHEN LOSS OF INPUT AC IS DETECTED	TTL LEVEL, SIGNAL WITH RESPECT TO PSRTN, 3mA MAX SINK CURRENT, 25mSec DELAY TIME TO ACTIVATE ON INPUT AC INTERRUPTS	2
OVERVOLTAGE PROTECTION	OVP SET-POINT: 345V ± 2%	OUTPUT VOLTAGE LIMITED; AUTO RECOVERY. BOOST FUNCTION IS INHIBITED WHEN OUTPUT VOLTAGE IS SENSED AT THIS VALUE. DURING INHIBIT, MODULE OPERATES AT √2*Vin(rms)	1

Notes:

1. **Ensured by design, not 100% tested in production.**
2. **100% tested for specification compliance in production.**

WAVEFORM DATA

Start-Up Profile (115Vrms / 400Hz, Cout = 3,400uF, Pout = 400W)

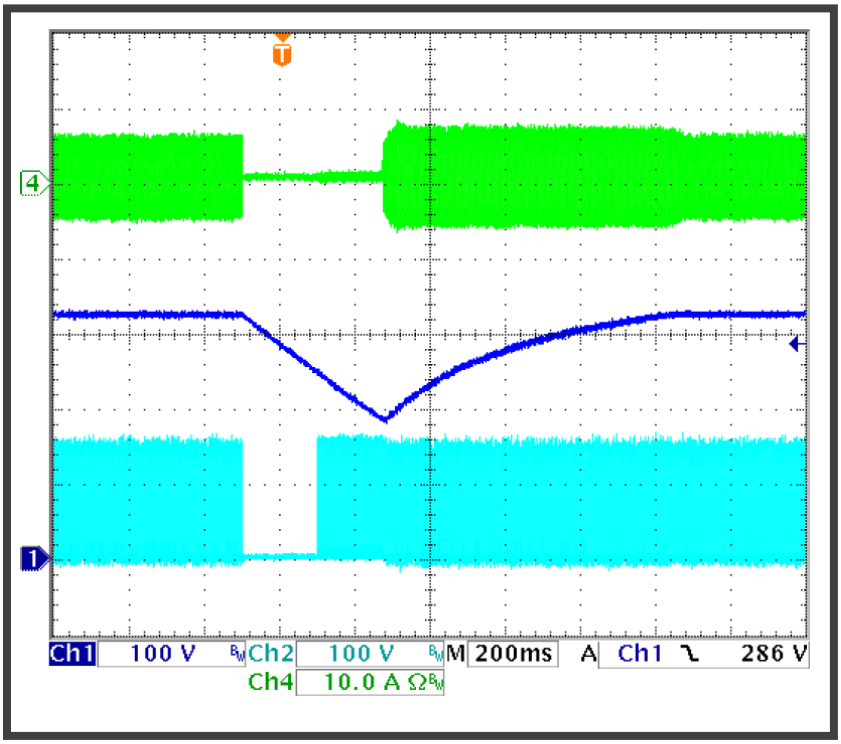


Input Current (CH4)

Output Voltage (CH1)

Input Voltage (CH2)

AC Interrupt = 200mSec (115Vrms / 400Hz, Cout = 3,400uF, Pout = 400W)



Input Current (CH4)

Output Voltage (CH1)

Input Voltage (CH2)

84005-400

(97—134Vac; 47– 440Hz Input)

400W, Single Phase,

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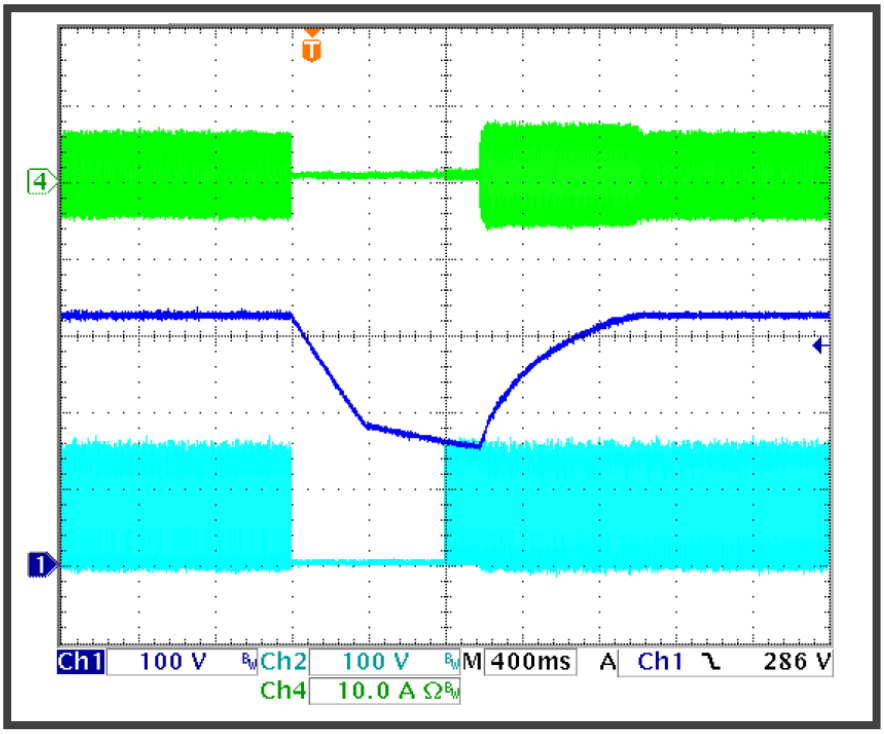
WAVEFORM DATA—CONTINUED

AC Interrupt = 800mSec (115Vrms / 400Hz, Cout = 3,400uF, Pout = 400W)

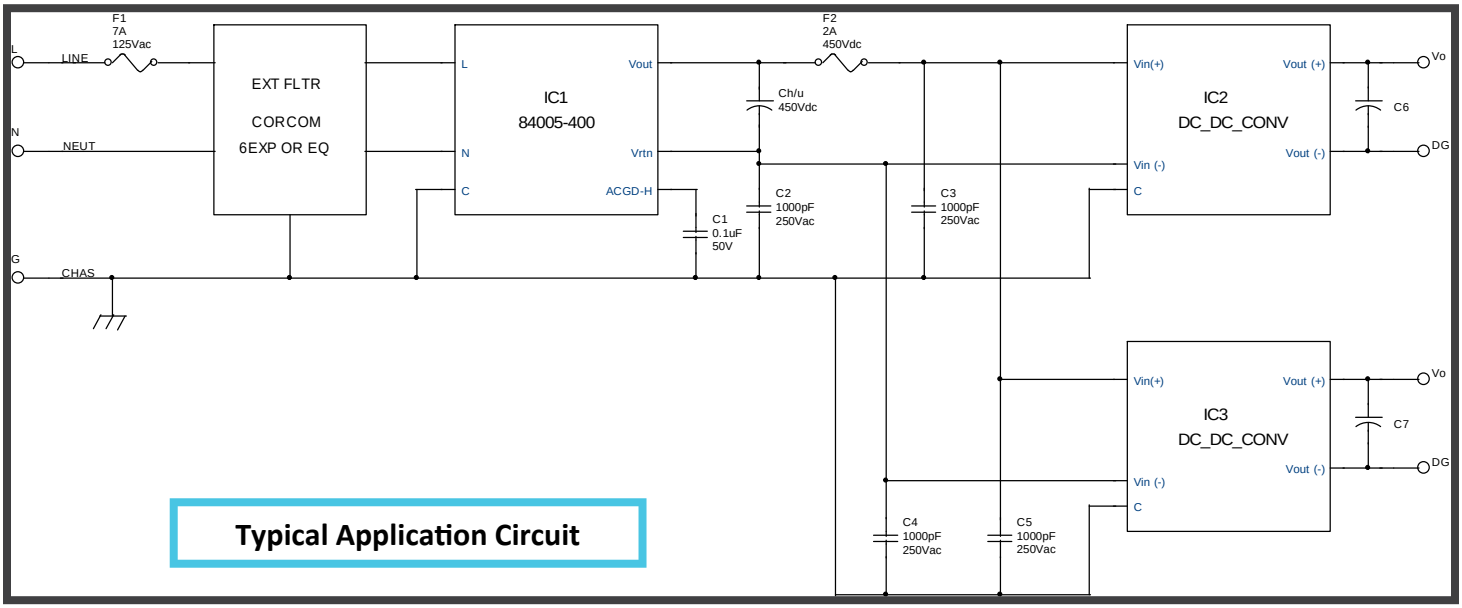


Input Current (CH4)

Output Voltage (CH1)

Input Voltage (CH2)

APPLICATION'S INFORMATION



Typical Application Circuit

HOLD-UP TIME

In order to extend configured power supply hold-up time, polarized 450V (minimum) electrolytic capacitors must be connected externally between the module's Vout and Vrtn pins. Required external capacitance can be determined using the following formula:

$E = P * (t + t_{restart}) = \{½ C_{h/u} (Vi^2 - Vf^2)\}$

Where,
P = External (downstream) DC/DC converter input power (Watts)
t = Desired hold-up time (Seconds)
$t_{restart}$ = Warm start delay of approximately 190mSec (200mSec max) upon reapplication of input AC
$C_{h/u}$ = External hold-up capacitance (Farads)
Vi = Minimum PFC output voltage = 325 Volts – 3% = 315V
Vf = Undervoltage shutdown level for downstream DC/DC converter (typically 180 Volts)

In order to hold up 400W boost converter output power for 200mSec requires:
$C_{h/u} = \{(400W) (200mSec + 190mSec)\} ÷ \{(1/2) (315V^2 - 180V^2)\} = 4670uF$

Use of 105°C, 450Vdc, 20% tolerance snap-mount aluminum electrolytic capacitors is recommended. For the example above, a total nominal capacitance of 5840uF would be necessary to assure the required capacitance of 4670uF was achieved. Warm start delay occurs for AC power interrupts less than ~400mSec as a result of combination of time to reactivate PFC control circuitry, reinitiation of PFC soft-start cycle and reaching module power limit.

EXTERNAL FILTER

The 84005-400 module requires an external filter on the AC lines for specification compliance. The filter shown in the typical application circuit above, Corcom p/n 6EXP, may be used for all applications requiring between 200W and 400W output power. For applications requiring less than 200W output power or to develop an external filter using discrete components contact PPI engineering for assistance.

EMI CONSIDERATIONS

Use of a chassis ground plane or aluminum surface beneath the non-metallic (silicon) module side is recommended. Although the 84005-400 module contains a differential mode input filter and common-mode suppression capacitors, the use of an external line filter is required for compliance with conducted emissions. See application circuit for suggested external filter.

If using an external filter comprised of discrete components, assure the current ratings of the differential and common mode inductors are sufficient. Avoid adding excessive line-to-line capacitance at lower output power levels (<200W output) as this may have an adverse effect on input current harmonic distortion when running distorted input testing (Vthd > 5%).

One or more of the external hold-up capacitors should be installed in close proximity to the module's output terminals (within 2 – 3 inches is recommended).

SAFETY CONSIDERATIONS

The 84005-400 module does not contain internal overcurrent protection. An external fuse installed in the line is required to assure proper protection in the event of a short circuit or low impedance fault condition on the modules output terminals or within the module's input EMI filter. A properly rated slow-blow fuse should be selected and tested within the application to assure it protects the module and wiring in the event of a fault while not nuisance tripping when cycling input AC power (as a result of charging output hold up capacitors).

THERMAL CONSIDERATIONS

There is no derating required for module output power up to the module's maximum baseplate temperature of 85°C. Beyond this temperature the module will shutdown. In order to assure the baseplate temperature remains below 85°C additional heatsinking or forced airflow may be required. In order to estimate baseplate temperature and whether external heatsinking or airflow is necessary, apply the following formula:

$T_{baseplate} = T_{ambient} + (P_{diss})(\Theta_{s-a})$

Where:
$T_{baseplate}$ = Module baseplate temperature in °C,
$T_{ambient}$ = Ambient air temperature in °C,
Θ_{s-a} = Thermal resistance from module baseplate to ambient air in °C/W without external heatsink,
eff = Module efficiency from appropriate curve,
$P_{diss} = \{(P_{out} \div eff) - P_{out}\}$ in watts

As an example,
Assume a desired output power of 400W at nominal line operation (115Vrms) with a maximum ambient temperature of 55°C. The following formula would apply:

$T_{baseplate} = 55°C + \{(400W / 0.89) - 400W)\} (1.3°C/W) = 119.3°C$

Therefore either an external heatsink or forced air cooling would be required such that Θ_{s-a} was reduced to:

$\Theta_{s-a} < \{(T_{baseplate} - T_{ambient}) \div P_{diss}\}$

$\Theta_{s-a} < \{85°C - 55°C\} \div \{(400W / 0.89) - 400W)\} < 0.61°C/W$